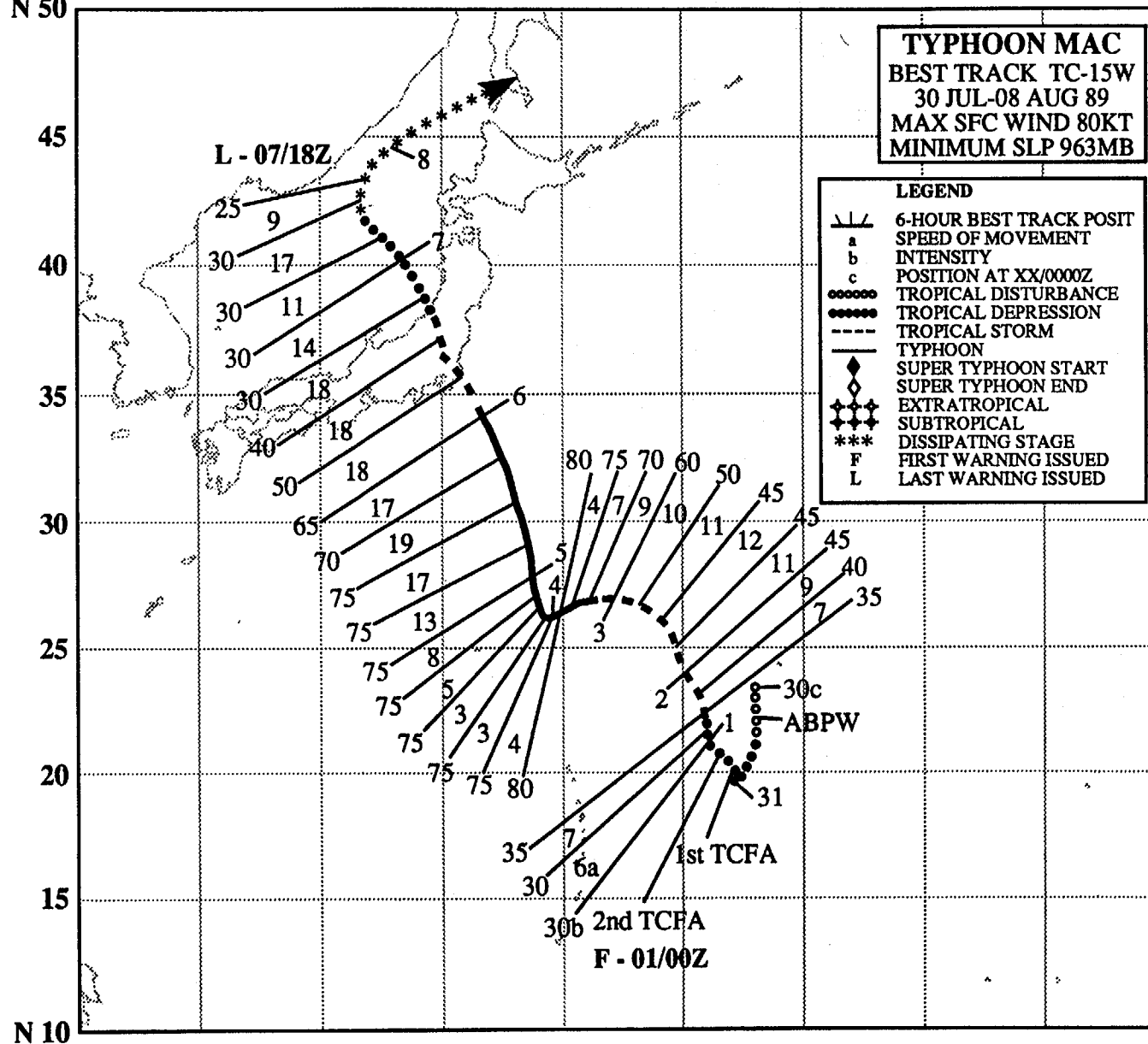


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## TYPHOON MAC (15W)

The first typhoon of August, Mac developed at a higher than average latitude. Its track and intensity were influenced by a complex mid-latitude synoptic regime and complicated by a multi-storm environment. JTWC and NOGAPS had considerable difficulty distinguishing between short-term and long-term trends. Developing northeast of the Mariana Islands, Mac began with a general northwest track, moved westward 48 hours, then accelerated on a northwestward track and made landfall northeast of Tokyo. Mac weakened rapidly as it moved into and across the Sea of Japan, and finally dissipated over southern Sakhalin Island.

As the most active July since 1973 came to a close, Typhoon Judy (11W) was dissipating over Korea and Tropical Storm Ken-Lola (13W) was threatening Okinawa. At the same time, an

area of convection developed approximately 600 nm (1111 km) northeast of Saipan in an extremely active monsoon trough that extended as far east as Wake Island. The 300000Z July surface analysis indicated that a low-level cyclonic circulation with a 1008 mb pressure was associated with an area of disturbed weather. JTWC classified the disturbance as having poor potential for further development on the 300600Z Significant Tropical Weather Advisory. Subsequent synoptic reports indicated that the central pressure had decreased to 1006 mb and surface winds had increased. Thus, JTWC reissued the Significant Tropical Weather Advisory at 301000Z to upgrade the disturbance's potential to fair.

The disturbance's central convection increased and additional synoptic reports indicated that the central pressure had fallen to

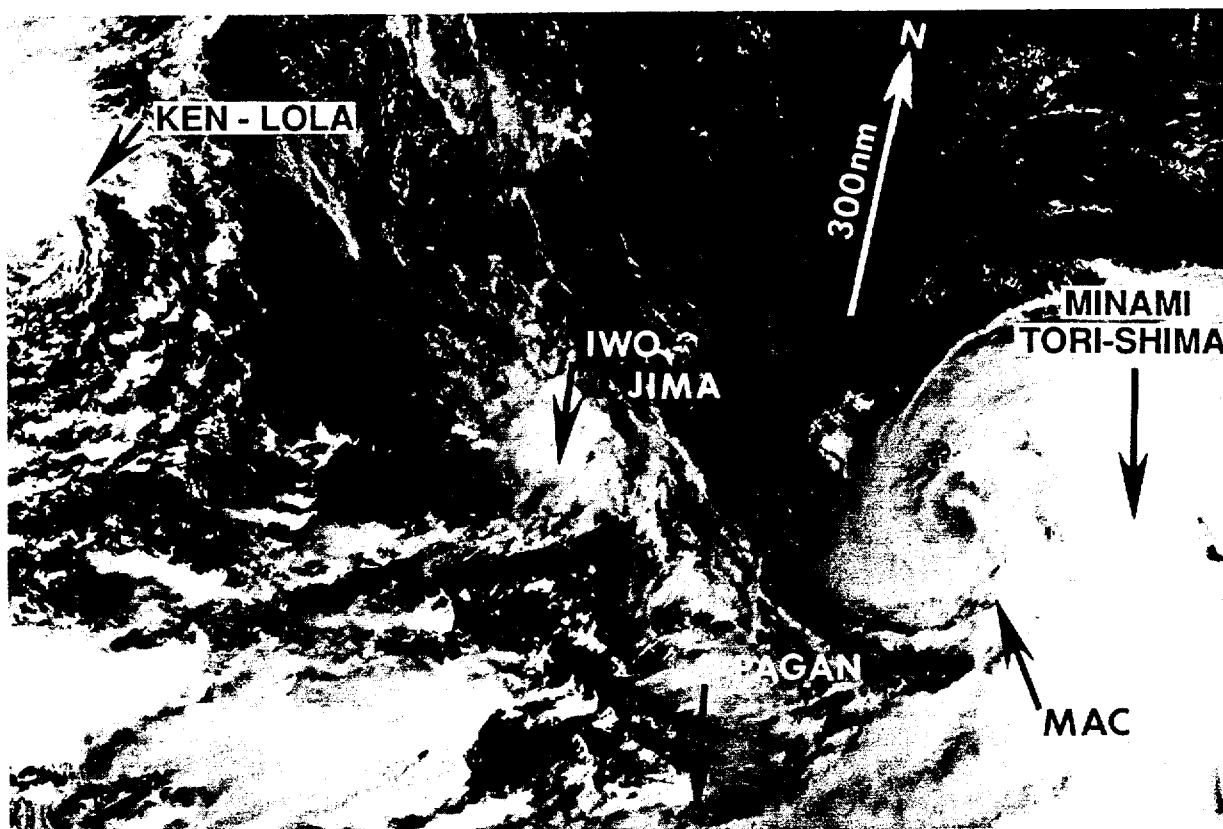


Figure 3-15-1. Mac's cirrus outflow (at left) is impressive compared to Ken-Lola (13W-14W) (012344Z August DMSP visual imagery).

1000 mb. The surface winds north of the system were 20 to 25 kt (10 to 13 m/sec) and monsoon gales were present to the south. JTWC issued a Tropical Cyclone Formation Alert at 310400Z with the disturbance moving to the southeast. Subsequent fix information indicated that the disturbance had actually made a cyclonic loop and was moving northwestward out of the Alert area. In response, JTWC reissued the Alert at 311700Z.

While the first warning on Tropical Storm Mac was issued at 010000Z August, post-analysis indicated that the system did not reach tropical storm intensity until 12 hours

later. The first series of forecasts called for Mac to track northward along the 150° east meridian. Due to the mid-tropospheric subtropical high weakening, the early stages of the forecasts verified well — as Mac tracked north-northwestward for the next 36 hours.

While Tropical Storm Ken-Lola (13W-14W) was in the vicinity of Okinawa on 2 August, JTWC changed its forecast outlook on Mac (Figure 3-15-1). The 020600Z warning had Mac moving westward along 30° north latitude in the 48- to 72-hour period as a complex series of events began to unfold. At the same time as a long-wave trough moved

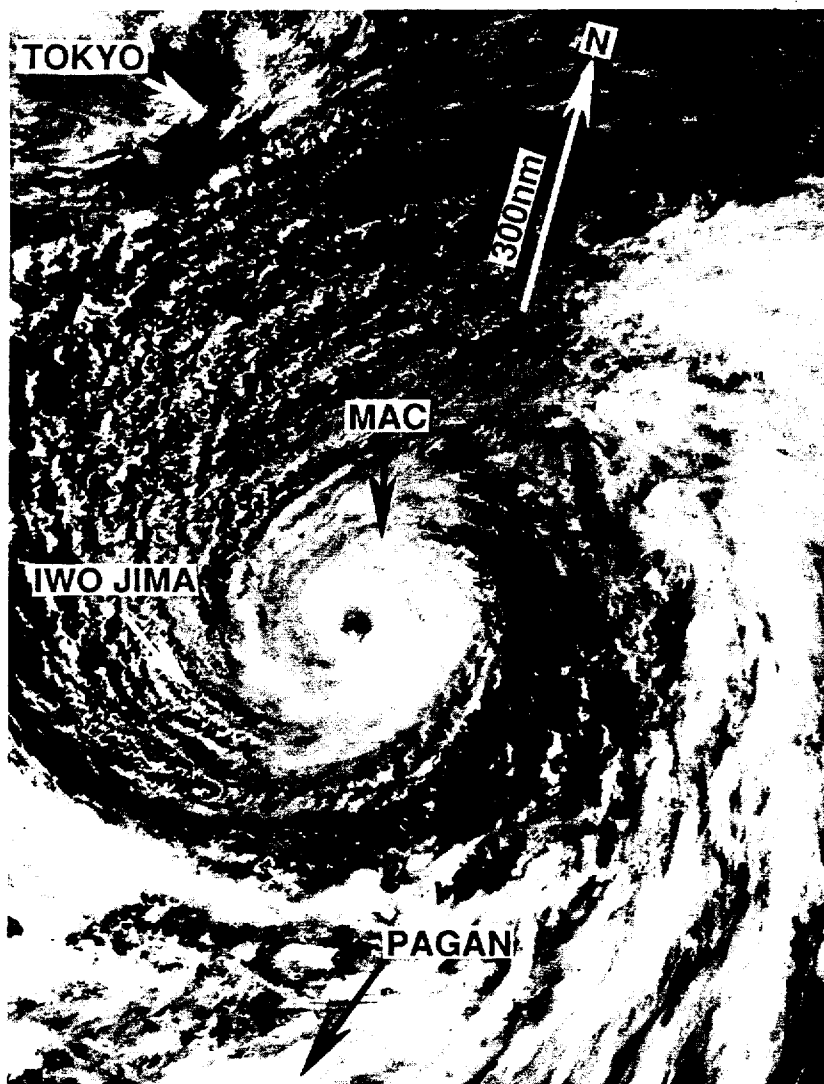


Figure 3-15-2. At peak intensity, Mac is surrounded by a ring of subsidence (032304Z August DMSP visual imagery).

eastward into the Sea of Japan, a large TUTT cyclone began to tumble rapidly westward from the date line. While the TUTT cell moved northwest of Mac, the mid-tropospheric subtropical ridge strengthened, placing Mac under the influence of easterly flow. This was similar to events that had recently forced Typhoon Judy (11W) to move westward. JTWC would remain with the westward track along 30° north latitude for the next nine warnings.

The westward movement began much earlier than forecast, in fact, along 27° instead of 30° north latitude and within 12 hours instead of 48 hours. Mac continued the westward movement for the next 48 hours reaching typhoon intensity at 030300Z. JTWC had high confidence in its forecast as NOGAPS built a high over the Sea of Japan and most of the objective techniques supported slow westward movement. Confidence was further heightened when Mac began tracking west-southwestward at 030000Z. JTWC forecasters recognized the unfavorable upper-level regime and displayed great success with the intensity forecasts. Mac reached its peak intensity of 80 kt (41 m/sec) at 031800Z (Figure 3-15-2).

During its westward track, an ominous slowing of Mac's forward speed occurred. At 040600Z Mac was moving very slowly west-southwestward. The 040000Z analysis indicated that a jet maximum approaching the trough axis which could deepen the trough. The Prognostic Reasoning accompanying the 040600Z warning did mention recurvature as a low-probability alternate scenario. JTWC's westward scenario was reinforced by the movement of a high from Mongolia to coastal Manchuria. Forecasters thought the continued eastward movement of that high and Mac's westward movement would allow the typhoon to escape the influence of the digging trough as ridging reestablished itself to Mac's north.

In the meantime, the TUTT cell that had tumbled westward slowed down and linked up with the mid-latitude trough in the Sea of Japan. This blocked significant eastward movement of the high over Manchuria and changed Mac's steering flow from westward to northward around the east side of the TUTT cell. JTWC added northward movement to the Prognostic Reasoning accompanying that 041200Z warning as a moderate probability alternate scenario. At 041800Z, the westward forecast was abandoned as Mac made a slow move northward and the new 041200Z NOGAPS no longer showed the high building over the Sea of Japan. JTWC swung the forecast track to the northwest toward Osaka near the 72-hour point. JTWC remained with that forecast for the next two warnings.

Meanwhile Mac had accelerated from 3 kt (6 km/hr) at 041200Z to 13 kt (24 km/hr) toward the north-northwest at 050600Z as it ran along the east side of the TUTT cell. The TUTT cell was expected to resume its normal southwestward movement causing Mac to resume a northwestward track toward Osaka. This reasoning was reinforced by height falls occurring *west* of Tokyo.

By 051200Z, Mac had accelerated to 17 kt (32 km/hr). At this time, JTWC shifted the forecast track to pass 180 nm (335 km) *east* of Tokyo within 24 hours. Satellite fixes indicated a northward movement and subsequent radar observations from Tori-Shima (WMO 47639) confirmed the north-northwestward track. In addition, the TUTT cell and an upper-level low over the northern Sea of Japan linked producing an extended trough. Mac would now maintain a forward speed of 17 kt (32 km/hr), or more, during the next 30 hours.

After 051800Z, Mac shifted from a north-northwestward course to a more north-westward course, as the trough in the Sea of

Japan began to weaken. Mac finally passed *east* of Tokyo at 060700Z, but only by 60 nm (111 km) with an intensity of 45 kt (23 m/sec) (Figure 3-15-3). The tropical cyclone made landfall at 061000Z. At 061200Z, Mac was downgraded to tropical storm intensity, however, post-analysis indicates Mac was a tropical storm at least six hours earlier.

Mac weakened while crossing Japan, but without the benefit of satellite intensity analysis and availability of continuous observations, JTWC conservatively maintained Mac at tropical storm intensity until 070600Z. MAC actually entered the Sea of Japan, near Sakata, as a tropical depression at 061700Z. The final warning on Tropical Depression 15W was issued at 071800Z. The remnants turned northeastward and dissipated over southern Sakhalin island on 8 August.

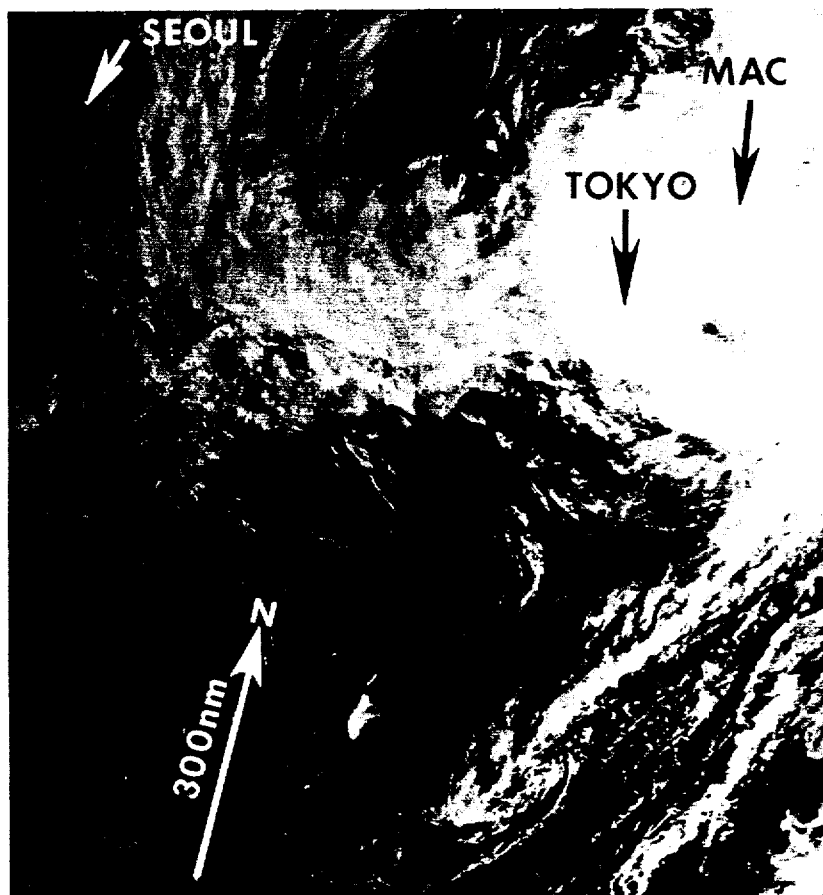


Figure 3-15-3. Mac approaches Japan (060438Z August NOAA visual imagery).